Remarks:

Claims 1-20 are in this case. All claims have been rejected. Claim 1 has been amended only to emphasize the importance of the fine delay differences of millimeters or less, that can be achieved using the inventive structure and method and to clarify the claim language. Such arbitrarily small delay time increments are supported in the Specification at page 5, lines 21-23. New claim 12 and its dependent claims a method of making the inventive structure. The claim is generally supported by the Specification in the detailed description, and in particular from page 3, line 6 to page 5, line 8. Claim 16 and its dependent claims claim the method of using the new structure and are generally supported by the Specification in the detailed description, and in particular from page 5, line 9 to page 6, line 13.

REJECTION UNDER 35 U.S.C. §103:

Claims 1, 3, and 6 are rejected under 35 U.S.C. §103 as obvious in view of U.S. Patent No. 5,018,816, "*Optical delay switch and variable delay system*", issued May 28, 1991 to Murray, et al. (hereinafter "Murray") in further view of U.S. Patent No. 4,671,605, "*Length dependent, optical time delay/filter device for electrical signals*", issued June 9, 1987 to Soref (hereinafter "Soref") and in further view of U.S. Patent No. 5,793,508, "*Wavelength-division multiplexing telecommunication system and method providing a controlled separation of the output channels*", issued August 11, 1998 to Meli (hereinafter "Meli"). These rejections are respectfully traversed.

It is well established in order for a combination of references to make a claimed invention obvious, the references must teach or suggest every limitation of the claim. The invention calls for a variable optical delay line comprising a plurality of fibers disposed in a closely spaced array. The array comprises a first

parallel region, a curved region, and a second parallel region. Each fiber has a first end disposed in a first linear array and a second end disposed in a second linear array. And, the second linear array comprises fixed reflectors. The curved regions of the fibers differ in radii of curvature to provide a successive series of monotonically different path lengths.

An important aspect of the invention is that the path lengths can differ by millimeters or less. And, reflectors disposed in each of the fibers can provide coarse delay increments. None of the references disclose such a structure.

Delay lines are important elements in optical communication systems. (Specification, page 1, lines 15-22). Variable optical delay lines are components that allow the selection of a specific delay from a range of available delays. Before electro-optics and the practice of Photonics, electronic delay lines were commonplace. While electronic delay lines were capable of nano second resolution, at the time of Soref's invention smaller electronic delays were problematic. One solution to that problem was to first convert electrical signals to optical signals, delay them, and then to convert them back to optical signals. Such systems as Soref's delay line, were capable of sub nanosecond delays. Soref claimed that his structure was capable of usable delta time delays as short as 10 pico seconds.

Modern telecommunication systems that are based on photonic (optical equivalent of electronic) circuitry requires far finer delays, on the order of millimeter differences in fiber delay line lengths. (Specification, page 2, lines 6-9). Reliable millimeter differences in lengths between successive optical fibers in a bundle cannot be achieved by convention cutting means such as used by Soref.

The inventors discovered a new structure that offers both fine millimeter selections (yielding ultra short delta time delays) as well as wide dynamic range by including switchable reflectors in the lengths of each fiber. The solution is to precisely lay an array of parallel optical fibers on a substrate with two parallel regions and a region of curvature to generate the fine delays. The course delays were then added by including switchable reflectors in each fiber.

The closest art is Soref. Soref discloses a very early selectable optical delay offered as a solution to achieving finer delays than were available two decades ago using conventional electronic delay techniques. Soref converts an electrical signal to be delayed to light, then does the delay in light and finally converts back to an electrical signal. Albeit state of the art in 1985, Soref's scheme is quite rudimentary judged against state of the art technology at the time of the instant invention. For example, Soref teaches the creation of a fine and a course delay selection by fabricating two banks of delays. The longer bank has a selection of longer delays with greater differences between the delay elements, and the shorter bank has respectively shorter net delays as well as difference delays. The selection of delay line paths is also very rudimentary and costly to build. It is based on a series tree selection structure of $LiNbO_3$ electro-optical switches. Each selected delay line comprises a series path of some 9 to 12 such switches. (Soref, figs. 1-4).

A major drawback of Soref's design is the need for additional banks of U shaped bundles of fibers to cover both gross and delta delay ranges. That is according to his circuit topology, each bank can achieve a net delay (on the order of the length of the fibers in the U shaped bundle) and a fine delay (due to the curvature of the U). To add different ranges, thus requires additional cascaded bundles. But, because each delay array includes losses caused by the required 9 to 12 electro-optic switches, no more than two Soref stages can be cascaded.

Soref realized this limitation, "*It is essential* that only two such time delay components be incorporated within the present invention in order to maintain minimal optical losses and produce accurately time delayed output signals". (Soref, col. 3, lines 31-35, italics added for emphasis).

The inventive structure allows for far more flexibility in the relationship between the range of delay available over the fine and course adjustments. And, by laying the fiber array precisely on a substrate, the range of fine delays can be an order of magnitude smaller than the smallest delay range possible using Soref's structure. The inventive structure can readily accomplish continuous monotonic delays on the order of millimeters or less (sub 10 pico second resolution). By contrast, the Soref structure is incapable of achieving such fine delays, "It is another object of this invention to provide a length dependent, optical time delay/filter for electrical signals which can generate "true time delays" in the 10 to 150 ps range". (Soref, col. 4, lines 23-24). But, Soref didn't contemplate the fine delays that might be useful in modern practice of Photonics. He was trying to solve to problem of achieving electronic delays with some measure of precision, "it is difficult to obtain ultra short delays in the 0.05 ns range". (Soref, col. 1, lines 58-59).

Thus it can be seen that while bearing some similarity to the invention (selectable fibers of differing length with a curvature), Soref is wholly devoid of disclosure of an array of fiber delays including course delay reflectors within the array of fibers. Moreover Soref is incapable of attaining the fine delays available with the inventive structure and method.

Murray is a very rudimentary selectable optical delay line comprising bulk optical fibers in a large box. The reflector is a bulk optical spherical mirror. (Murray, figs. 1 and 4). This 1991 patent does not contemplate fine optical delays as provided by an array of optical fibers. Nor does Murray disclose the addition of reflective elements within the fiber lengths to provide course delay selections.

Meli is proffered only to supply the element of Bragg reflective element. But, Meli contemplates little more than a "a delay line of predetermined length" with respect to the inventive use of reflective elements. (Meli, claim 29). Meli does not disclose any type of variable optical delay line whatsoever. Merely proffering the source of an optical element is insufficient grounds for the inclusion of a reference in a combination for an obviousness rejection. It is widely accepted in practice that there must be some suggestion, motivation, or teaching in the references that would cause one skilled in the art to combine them. Meli is wholly devoid of such material.

Soref does not disclose the inventive variable optical delay line with ultra fine time difference delays combined with course settings by reflectors within a fiber array. Taken alone or in combination, neither Murray, nor Meli remedy the deficiencies in Soref. And, the dependent claims are correspondingly not rendered obvious by the aforesaid references as the dependent claims contain additional limitations beyond the independent claims not made obvious by these references.

All rejections are thus respectfully traversed. It is believe that the application fully complies with all provisions of 35 U.S.C. §103. The application should be allowed.

Respectfully submitted,

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